Physical Properties of Sheets and Yarns Drawn from Arrays of Multi-walled Carbon Nanotubes

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Individual carbon nanotubes (CNTs) exhibit outstanding electrical, thermal, and mechanical properties, but the realization of many applications requires that these properties be translated to macroscopic structures. To this end, 3-dimensional CNT structures have been built and their properties investigated: yarns and sheets. These structures were built from aligned CNT arrays grown by a water-assisted CVD process, their thermal conductivity ranging from 0.5 to 1.2 W m^{-1} K^{-1} [1]. The yarns/sheets are made by pulling a bundle of CNTs from the sides of these arrays and layering them using a system of motors, capable of making 100's of meters of continuous pure CNT macroscopic structures [2]. One problem that becomes apparent for thermal property measurements is the inability of the CNT structures to support the thermometry needed for conventional 1D thermal conductivity measurements. That issue was addressed by employing the parallel thermal conductance (PTC) method [2]. The key issue with the PTC method is that the background conductance, normally contributing little, is now a major contributor and must be precisely determined and subtracted from the total conductance; this method will be discussed in detail. The room temperature thermal conductivity of 10 micron CNT yarn was found to be 60 ± 20 W m^{-1} K^{-1}, the highest measured result for a pure CNT structure to date [2]. Thermal, electrical, and mechanical results for the yarns and sheet will be discussed in this talk.

[1] M.B. Jakubinek, M.A. White, G. Li, C. Jayasinghe, W. Cho, M.J. Schulz, and V. Shanov. Thermal and Electrical Conductivity of Tall, Vertically Aligned Carbon Nanotube Arrays. Carbon. 48, 3947 (2010).
[2] M.B. Jakubinek, M.B. Johnson, M.A. White, C. Jayasinghe, G. Li, W. Cho, M.J. Schulz and V. Shanov. Thermal and Electrical Conductivity of Array-spun Multi-walled Carbon Nanotube Yarns. Carbon. 50, 244 (2012).